National Park Service photograph

Figure 7. Bear 'mark-trail' in Reid Inlet, Glacier Bay.

very brushy sites reduce visibility and increase the chance of surprise encounters. Also, steep cliffs may restrict bear movements such that bears are funneled into campsites, thus increasing the odds of bear-human encounters.

We incorporated this information into a research plan that enabled us to estimate bear habitat quality and bear encounter and conflict probabilities at the most frequently used campsites in the bay. Because Glacier Bay is comprised largely of steep-walled fjords, level areas that produce high quality bear forage are relatively rare and are important to bears. The presence of camping activity may displace bears from these areas; hence a rating of displacement potential was deemed an important aspect of this work. An overview of the steps in the campsite risk assessment process is presented in *Figure 6*.

Status of Research

During the summers of 2001-2002, we evaluated 162 campsites, traveling to campsites by kayak. We estimated bear habitat quality, bear displacement potential, and bear-human conflict potential at each site. Additionally, all bear sign (e.g., tracks, scats, digs, rubs, marked trees and trails) observed at each site was recorded and entered into the geographic information system *(Figure 7)*. In the future, we will determine if the level of bear sign observed during our evaluations and the number of sightings in the historic database correspond. Subjective ratings for bear habitat quality will also be compared to the level of bear sign and sightings in the database.

Many coastal habitats in Glacier Bay, particularly the upper reaches of the glacial fjords, appear to be marginal habitat for bears. Dominated by barren rock, sheer cliffs, alder scrub (Alnus spp.), and dryas (Dryas spp.), these areas offer inferior foraging opportunities and difficult travel conditions for bears. Nonetheless, bear sign was found in all of these places.

Preliminary Research Findings

The Glacier Bay bear sightings and incidents database was completed in 2001. Campsite evaluations were completed in August 2002. Campsite data were analyzed during the winter of 2002-2003 and findings are to be released in 2003. Our analysis of 70 years of bear sightings and bear-human conflict from the database has revealed a number of interesting facts.

Bear Conflicts Database Findings

We found that in more that 98% of all reported encounters, bears did not injure people. Although black bear sightings (2100) outnumbered brown bear sightings (1300) nearly 2 to 1, both black and brown bears were almost equally involved in conflicts with people (56% vs. 44%). Eighty-five percent of bear conflicts occurred between 6 a.m. and 6 p.m., and human foods were a factor in conflict nearly half the time (42%). We also found that single campers were more often involved in bear conflicts than

camps with 2 or more people, and red pepper spray was successful in deterring bears in 5 of 8 instances reported. Our assessment of information supplied by those involved in bear conflicts suggests that people were responsible for precipitating conflicts twice as often as were the bears.

Preliminary Campsite Assessment Findings

Bears are ubiquitous at Glacier Bay. Backcountry users should realize that bears might appear anywhere at anytime, including islands. Indeed the saying, "Bears are where they find you," is particularly true at Glacier Bay. The West Arm of Glacier Bay has more abundant and diverse bear habitat than the East Arm. Consequently, more bear sign are present on West Arm beaches. The greater number of bear sightings and bear-human conflicts on the West Arm than on the East Arm support this finding. Many coastal habitats in Glacier Bay, particularly the upper reaches of the glacial fjords, appear to be marginal habitat for bears. Dominated by barren rock, sheer cliffs, alder scrub *(Alnus spp.)*, and dryas *(Dryas spp.)*, these areas offer inferior foraging opportunities and difficult travel conditions for bears. Nonetheless, bear sign was found in all of these places. Bears using these areas likely travel constantly in search of food, suggesting that camper use of higher quality foraging areas here may have a pronounced negative effect on bears.

Implications

The Glacier Bay bear sightings and incidents database is a tool that can aid park managers in the management and analysis of bear information. Efforts are underway to implement a version of the database in the National Park Service's Regional Office in Anchorage. When completed, the database will enable park managers to track bear-human interactions at all Alaska National Park units. In addition to placing bear-human interactions that occur into a regionwide perspective, we anticipate that information from this system will help identify future research needs. Additional information may be accessed at: http://www.absc.usgs.gov/research/brownbears/glacierbay/glba.htm .

Photograph courtesy of Kent Fredriksson © 2003

Acknowledgments

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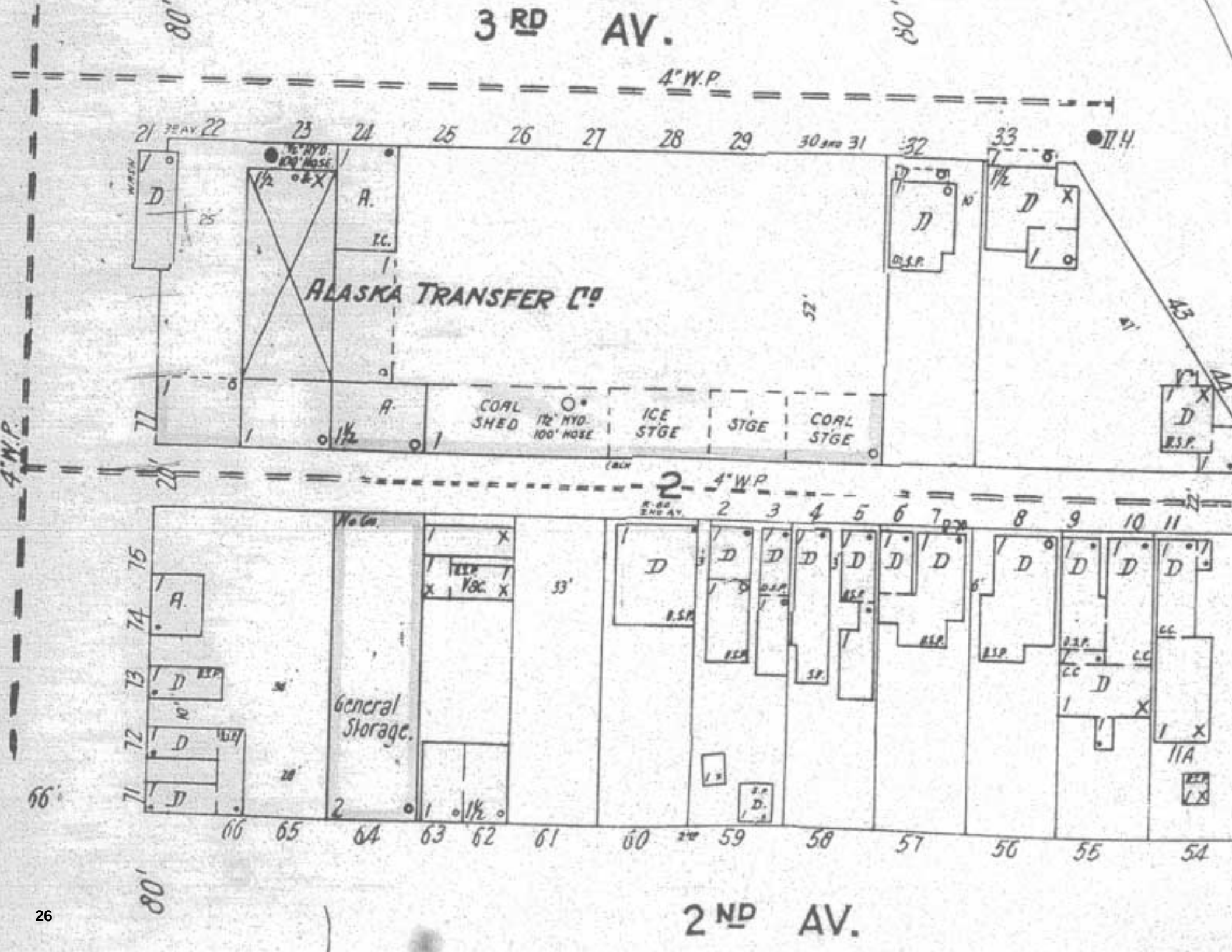
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Red Light District Ethnohistory in Seward, Alaska

By Rachel Mason

National Park Service photograph

Line of trees in Seward where the Line once was.

Left: 1927 Sanborn map showing the properties on the Line.

National Park Service photograph

In 2002, a team of National Park Service historians, architects, archeologists, and cultural anthropologists began a compliance study for a new visitor center in Seward associated with Kenai Fjords National Park. The proposed site of the new visitor center was in the same area of Seward as the Line, a red light district that closed in 1954. The ethnohistorical section of the study involved interviewing local residents about their memories of the Line. The enthusiastic responses both to requests for interviews and to public lectures was amazing. The community's appetite for hearing and talking about the Line seemed insatiable.

Both while the Line was open and long afterward, people in Seward thought the prostitutes who worked there provided a necessary commercial service to transient men. Respectable women supported the Line, in an effort to confine vice to a single part of town. The Line women usually did not socialize with respectable women or even appear in public except at certain times. Despite the prostitutes' isolation, though, one of the main conclusions drawn from researching their history is that one can not talk about the Seward Line without talking about the whole community.

Local historians have documented much of Seward's early history. Mary Barry's three volume history gives detailed year-by-year accounts through 1993. John Paulsteiner, Barry's father, wrote a somewhat different book called *Seward, Alaska: The Sinful Town on Resurrection Bay,* published in 1975. Focusing on bootlegging, prostitution, and other illegal activities, the book shares personal vignettes of the characters that populated the town.

The interviews for this ethnohistory were conducted with several people who were children during the days of the Line. While some were delighted to help piece together the history of the Line, others were more hesitant. One woman was quite reluctant to contribute to a study that might ridicule or romanticize the prostitutes. She had known several of them personally and emphasized that they were just ordinary people trying to make a living.

Seward, founded in 1903, has seen several employment and population booms during its 100 years. A large number of military personnel were stationed there during World War II, most of them young, single men. During those busy days, soldiers on leave stood in line for admission into the Line houses; the prostitutes did not have time to provide much companionship to their customers.

Then, at other times when transient male workers swarmed the community, residents tolerated and indeed supported prostitution. From 1914 to 1954, a row of small houses along Alley B was the city's recognized red light district. Although prostitutes typically move from town to town, many of the Seward ladies stayed for the rest of their lives, buying property and businesses, and sometimes marrying local men.

While most of the adventurers who came to Seward were men, female travelers arrived as well. Working on the Line was only one of the moneymaking opportunities an ambitious, independent woman might find. Respectable single women worked as nurses and teachers. Other women established small businesses, such as laundries. A likely business venture for a prospective madam was to buy real estate. The records of lot sales on the Line show a rapid turnover of ownership among people whose names we recognize as those of prostitutes or madams.

Opening the Line

Many towns in the Alaska Territory, as elsewhere in the American West, had

Photo courtesy Seward Community Library

Panoramic view of Seward in about 1915. The Line is the small row of houses on the far right.

special red light districts. Often, the prostitutes' quarters were a line of little houses, or cribs, along a road or alley. The Seward Line consisted of a row of houses along Alley B between Second and Third Avenues, and between Railroad on the south and Washington on the north. Its location near the dock made it convenient for seafaring customers. While numerous immoral and illegal activities were thought to take place on the Line, its central function was prostitution. The houses averaged perhaps 16 by 20 feet. While archeologists have identified as many as 26 houses along Alley B, not all were occupied at the same time. Some interviewees remembered only five or six women working on the Line at one time; however, most agreed that usually two girls resided in each house. Undoubtedly the number of prostitutes increased or decreased depending on the demand for services.

In 1914, Seward became the official terminus of the Alaska Railroad. Days before President Wilson signed the Alaska Railroad Bill, a member of the Seward City Council requested that the city provide a restricted district to accommodate "denizens of the underworld" (Seward Gateway, March 7, 1914). The Council enacted an ordinance making keeping a bawdyhouse a misdemeanor, with a punishment of five days in jail or a $25 fine — similar to the punishment for raising a false fire alarm *(Bateman 2002)*. Collected each month, the fines were a regular source of revenue for the city.

Women of the Line

Below are descriptions of some of the memorable women from the Seward Line:

Lydia Griffiths, a madam, bought several lots on the Line soon after it was established in 1914. She married Al Peel, who had been the town marshal *(Capra 1996:11)*. Lydia appears in the 1920 census as a 53-year-old woman, and, curiously, as a 52-year-old in 1930. The latter seems more correct, as Lydia died in 1947 at age 68. The Peel-Griffiths house, spared in the 1964 earthquake, remained standing until it was burned as a fire department training exercise. The house's interior was ornately decorated with red velvet brocade furniture.

Stella Brown, a well-known prostitute in the 1930s, was from a prominent East Coast Jewish family. Stella sometimes asked Lee McAnerny, then a teenager, to help write letters to Stella's young daughter in New York. Lee and stepfather Sol Urie also prepared Stella's income tax returns, which showed her income to be one of the highest in the Territory.

Dutch Emma, whose real name was Marie Hadley, was probably the best known prostitute and madam. She owned several houses on the Line, one of which was moved to Second Street and is still standing. In the mid-1940s, Dutch Emma bought the Mile Seven Roadhouse and ran it with her husband or boyfriend Hooligan Slim Gunners. She died in 1950 at age 69 and is buried as Marie Hadley in the Seward cemetery.

Helen Williams, also known as Irene Nussbaum, was an important madam in

A man who had been a young GI in Seward during World War II remembered being terrified by Francie when he went over to the Line to meet a friend. He was sitting in one of the chairs outside Francie's house when she came out and bellowed, "Who's next?" — and he took off running.

the 1940s. She employed Emilio the Greek, who was really Italian, as her chauffeur. He would wear a leather bow tie and spats and drive her around in a fancy maroon Buick. In 1956 Irene bought a laundry *(Barry 1993:235)*, later renting it to a young couple, Duane and Sanna LeVan.

Carol Erwin was one of the last ladies on the Line. Her autobiography, *The Orderly Disorderly House (1960)* talks of the bawdy-houses she operated in Texas and elsewhere before coming to Alaska, where her adventures briefly included Seward. A talented artist, she usually painted landscapes. In the 1940s, the Seward Women's Club sponsored one of her art shows, marking an unusual rapprochement between respectable women and Line ladies *(Erwin 1960:210)*.

Elnora or **Francie Jones** was an African-American woman who worked on the Line and also ran a barbecue restaurant called Elnora's. A man who had been a young GI in Seward during World War II remembered being terrified by Francie when he went over to the Line to meet a friend. He was sitting in one of the chairs outside Francie's house when she came out and bellowed, "Who's next?" — and he took off running. Elnora remained in Seward after the Line closed, but was arrested by the Vice Squad in 1957.

Lives of the Line Women

Most of the prostitutes were white. Several people remembered one black woman on the Line, but no Alaska Natives or Asians. Residents did recall that the prostitutes in Seward seemed unusually old, far above what they imagined were the normal peak years for prostitutes. Perhaps because of the ladies' advanced age, none of the people we interviewed remembered seeing pregnant women or women with small babies on the Line.

Prostitutes on the Seward Line did not find it necessary to dress very provocatively to vend their wares, supporting the local idea that prostitution was a practical way to satisfy a natural urge, and not one that needed to be sold. One woman said that the prostitutes dressed well, in fact much better than the average woman in Seward.

In the early days, women who worked on the Line were practical entrepreneurs. They were not drug addicts, had not suffered traumatic childhoods, and were not especially impoverished. Other than for prostitution, they did not often run afoul of the law. No one remembered any local women who joined the Line; all the women came from somewhere else.

According to one person, the women's fees were $2 or $5, depending on the services performed. Another thought they charged $5 in summer and $3 in winter. The main status distinction was based on whether the women were independent operators who owned their houses. If they worked for madams, they turned over a portion of the money they made. There is little mention of pimping in the accounts of the Line. Also, there was no evidence of turf battles between the woman-owned businesses.

Some of the best clues about the lives of the Line women come from the seemingly mundane details our oral history informants dredged from their memories. A woman remembered bicycling through the Line as a girl, and hearing boys her age tittering about seeing a naked woman in one of the houses. Mary Barry, for a brief period, walked Dutch Emma's dog. She remembered that Dutch Emma had a garden, and used to give vegetables to Barry's family.

When Lee McAnerny was a teenager, she worked at her stepfather's bakery and remembered talking with some of the women from the Line. She was impressed by their stylish clothes, bought in New York, and by the fact that the ladies had the latest fashion magazines and sometimes gave her make-up tips. Often the women ordered fancy pastries to be delivered to the Line, and Lee's brothers usually made the deliveries, although they were much younger than her.

One man said he had paid $20 for the coveted paper route in Seward's red light district. A woman who, as a young, embarrassed public health nurse, said she had the task of making house calls to prostitutes to check them for venereal diseases. Beverly Dunham remembered that the ladies from the Line would come to the store where she worked and buy records to play during their rendezvous. The most requested song

Photo courtesy Resurrection Bay Historical Society

Lydia Griffiths and Al Peel, date unknown.

National Park Service photograph

Rachel Mason giving public lecture about the Line in Seward in May 2002.

Photo courtesy of Duane and Sanna LeVan

Irene Nussbaum, early to mid 1950s.

National Park Service photograph

Dutch Emma's house in 2002. It had been moved from the Line to Second Street.

was "Embraceable You," a popular song in the early 1950s.

Beverly Dunham also told a story about Dutch Emma. Beverly's brother-in-law was a practical joker. When her mother was in town looking for some property, her brother-in-law fixed it so that Dutch Emma showed her around town in a big black car, complete with driver. They even went together to one of the bakeries to have coffee and donuts. When her mother arrived home, the brother-in-law informed her that her afternoon companion was a prostitute. She was mortified and refused to leave the house for weeks. Dutch Emma was either unaware of the joke or too gracious to identify herself to her guest. In fact, since she owned so much real estate in Seward she was an appropriate person to show houses. However, at the time a respectable woman did not want to be seen in a car with women like her, regardless of how much money or land they had.

Seward's Moral and Social Climate

We get some sense of the moral climate in Seward from the newspapers of the time. Even in the early days of the city, there was a practical, unabashed attitude toward sex, at least in some circles. A 1914 advertisement in the Seward Gateway for a 320-page illustrated *Book of Sexual Knowledge* touted it as a comprehensive work useful to doctors, lawyers, Sunday school teachers, and anyone else who needed to know about sex matters. It was delivered in a plain wrapper for only $1.00.

The 1930 census data for Seward show a total population of 504, of whom 150 were female. Again, few adult women were unmarried. While married women were generally listed as housekeepers or homeowners, single women's occupations included teacher, waitress, store clerk or manager, laundress, tailor, cook, and servant.

In a 1985 interview, the late Virginia Darling told of the prostitutes' self-imposed isolation from respectable society. When Virginia was a small baby, her mother came to Seward from Seattle on a boat. Virginia's mother was terribly seasick, and a nice woman helped her with her baby. The nice woman turned out to be Lydia Griffiths, who owned several houses on the Line. After that, Virginia's mother said hello to Miss Griffiths when she saw her at the beauty shop. Later the beauty operator delivered a message from Miss Griffiths that she appreciated the greeting but she preferred not to be acknowledged in public.

While the prostitutes themselves were segregated from society, the community accepted the institution of prostitution as a necessary part of life. Herman Leirer, now deceased, used to run a dairy. In a 1994 report, Leirer said that after the Line closed, there was no more control over prostitution. The prostitutes were good citizens, he said. In all the years that he delivered milk to them, he was only swindled out of $8.25. He thought that was "pretty damned good" *(Mobley 1994:22)*.

Periodically, ministers and churches tried to close down the Line or made other efforts in the name of morality, though not all did. One of the ministers, in fact, was occasionally found down on the Line with some of the other businessmen, because the Line was the only place to buy a drink after one o'clock in the morning.

The Line was not physically walled off from the city, but most of the time the upstanding residents preferred to ignore it. A citywide cleanup in the spring of 1950 sent Boy Scouts to gather up debris in the alleys between First and Second Avenues, and between Third and Fourth Avenues. Conspicuously, they did not clean in the alley between Second and Third, where the Line was located *(Seward Seaport Record 1950, May 2)*.

The Closure of the Line

Mystery shrouds the closure of the Line in the 1950s. The only reference definitely dating its closure came in the Seward Seaport Record on March 19, 1954. In a front-page article, the mayor denied flatly that he had ever told Police Chief Don Balmat to "re-open" the Line. Mr. Balmat had resigned as police chief after an altercation on the Line: one of his officers had caused a disturbance by trying to help a naked prostitute retrieve her clothes from the house where another prostitute and a bartender were celebrating their wedding night. Subsequently, Balmat placed charges against the city for legalizing the Line — a futile effort, since the city had no record of officially endorsing prostitution. Sometime

in 1954, however, the city stopped even informally allowing prostitutes to operate. The women of the Line left town, took up other businesses, or became freelancers.

There's not much left of the Line in Seward today. Long ago, the little houses burned down, were destroyed in the 1964 earthquake, or fell to urban renewal. Now, a north-south line of trees marks where Alley B was *(Mobley 1994:22)*.

Changing Memories

Many of those who remember the Line were children when the prostitutes were there, and did not fully realize what was occurring. Some of the young wives made it their business not to know about the Line. Also, men and women have different memories: men remember the prostitutes with hearts of gold; women remember the part of town where they were not supposed to go.

The story of the Line is part of the story of Seward. The prostitutes were separated from the community, but their segregation appeared voluntary. They were not supposed to mingle with the "good" people except during certain hours. They were a buffer between the real outsiders —the military, the railroad men — and the core community. As Willard Dunham said,

Well, in the first place, they were part of the community...And they were in business. And, I doubt that if there's any, or very many, old businesses that go back into the early days that the girls of the Lines of the various cities weren't connected to financially. They were where you went to get money when the banks or the rest of them didn't want to loan money, or didn't want to loan the amount that you wanted. A big share of the old madams all dabbled in real estate. They were just part of the community...

In the good old days, the prostitutes did not steal, at least not from locals. They brawled with each other, but did not injure any Seward residents. There were no pimps, only good-hearted madams. They may have been addicted to alcohol or drugs, but did not appear as hardened as later prostitutes. For all the sin it describes, Paulsteiner's book tells of Seward in an innocent day. Even the bad guys seemed somehow harmless. The fates of bootleggers and prostitutes are intertwined with the fates of the upstanding citizens of the town.

Seward residents who remember the Line disagree on details, such as the exact number of prostitutes, their stage names or real names. What emerges from their memories, though, is a strong sense of community that included both the Line and the people around it. Through unspoken understandings and city ordinances, Seward's citizens not only tolerated but actively embraced the women of the Line.

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Photograph courtesy of Carol Ann Woody

Figure1. Sockeye salmon complete their life-cycle by homing from the ocean to freshwater natal habitats where they lay their eggs in rocky nests and die soon after.

Figure 2. Left: After salmon die, nutrients released from their carcasses increase productivity at all levels of the food chain.

Photograph courtesy of U.S. Geological Survey

Unlocking the Secrets of Lake Clark Sockeye Salmon

By Carol Ann Woody

Sockeye salmon are a cornerstone species in many Alaska watersheds. Each summer, adults lay eggs in rocky nests called "redds," and they die soon after. In spring, their fry emerge from gravels and then rear in a nearby freshwater lake for one year or more before migrating as smolt to the sea. During this smolt phase, an olfactory map of their route is imprinted on their memories. Sockeye salmon spend one to four years in the ocean feeding and growing. Then, some innate cue sends them back in a mass migration to their natal lake systems, which they find using the olfactory map made years before. They complete their life cycle by spawning, then dying in habitats of their birth.

Sockeye salmon transport millions of tons of nutrients from the rich marine environment to Alaska's nutrient poor freshwaters. The annual nutrient influx links aquatic and terrestrial environments through species that feed on them such as gulls, eagles and brown bears. Nutrients from spawned-out salmon carcasses increase production at all levels of the food chain and play a crucial role in sustaining productivity of Alaska's ecosystems, including the perpetuation of future salmon runs. Salmon have been shown to play a key role in the distribution and abundance of more than 40 species of fish, birds, and mammals. Humans are among the many species relying on salmon for sustenance.

One of the world's largest and most productive sockeye salmon systems is the Kvichak River watershed *(Figure 4)*. Lake Clark National Park and Preserve is part of this watershed and was established, in part, to protect freshwater habitats important to sustained sockeye salmon production. Most of Kvichak salmon production is attributed to fish originating in Lake Iliamna, even though one study indicated up to half or more of the return may sometimes originate in Lake Clark.

Sockeye salmon originating in the Kvichak watershed have been a primary protein resource for Native Alaskans for

Photograph courtesy of U.S. Geological Survey

The outlet of Lake Clark, Kvichak watershed.

Photograph courtesy of Kent Fredriksson

Figure 3. Research indicates from 30-90% of a coastal brown bear's body can be traced to marine derived nutrients brought into freshwaters by salmon.

thousands of years and remain an integral part of their diet and culture. Salmon preservation techniques such as salting, drying and smoking fish allowed early peoples to stockpile food and survive the long winters. Today, sockeye salmon comprise up to 75% of local subsistence users' diets and are an incredibly rich food resource, high in lecithin and Omega 3 fatty acids.

Sockeye salmon have been commercially fished in Bristol Bay since 1883. This multi-million dollar ($60-$400 million) industry is the economic backbone of the region. The sockeye salmon from the Kvichak watershed are the dominant producer, although the number of fish returning is highly variable (0.23 to 55 million fish). The Kvichak return exhibited a cyclic abundance pattern of three high years in five during 1900-1930s, then a fairly predictable one to two high years in five during the mid-1930s to mid-1990s. Since 1996, returns to the Kvichak have become unpredictable and consistently lower than historical levels. Return per spawner (R/S), or the number of fish returning for each fish that spawns have also been low, indicating the breeding population is not replacing itself.

Continued declines in sockeye returns to the Kvichak watershed resulted in the region being declared an economic disaster area for multiple years. The commercial and sport fishing industries are struggling to remain economically viable. Native Alaskan subsistence users are fishing longer yet catching fewer fish; some have had to move traditional subsistence fishing sites for lack of fish. Subsistence fishers are concerned that their main protein resource will continue to decline. In addition, they will have to replace it with inferior, expensive sources just as the dominant employer, the commercial fishing industry, is in severe decline.

Ecological repercussions from the salmon decline to the Kvichak watershed are currently unquantified, but production at all levels of the food chain is likely diminished. Once comprising over 50% of the salmon caught in the multi-million dollar Bristol Bay fishery, in 2002 Kvichak sockeye salmon made up 0% of the catch. For the last three years, sockeye originating in the Kvichak watershed have continued to decline, and a minimum escapement goal (the number of fish not harvested) of two million has not been attained, although neighboring sockeye salmon systems are increasing in abundance.

Photograph courtesy of Carol Ann Woody

Figure 5. June Tracey of Nondalton puts up fish for the winter, following techniques developed by her ancestors.

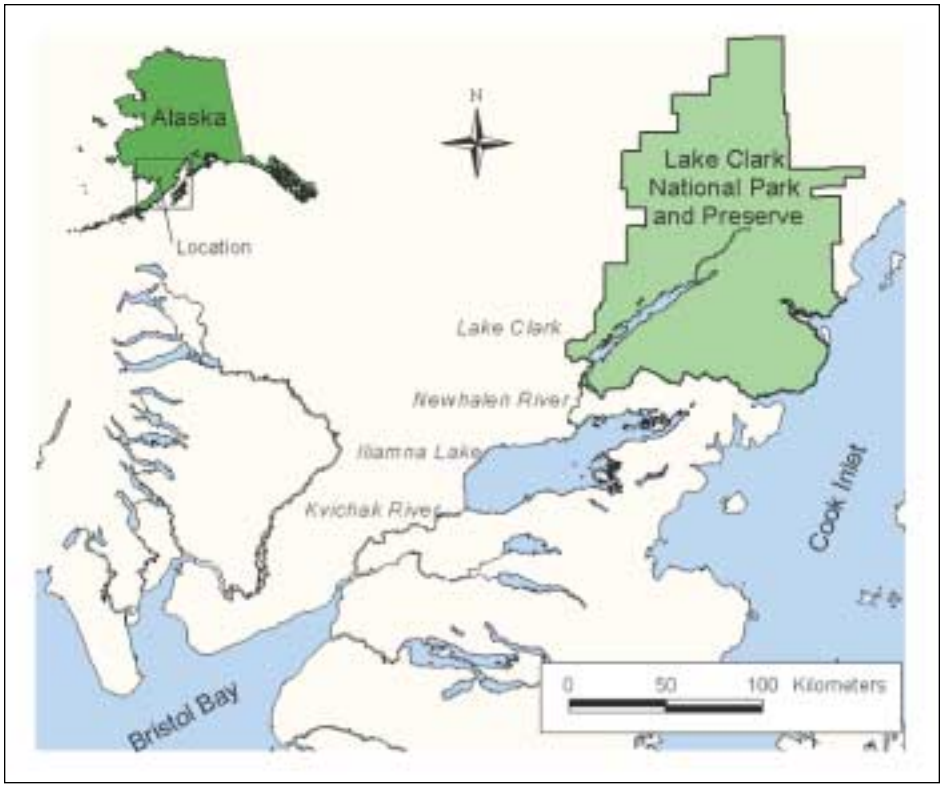

Figure 4. Location of Lake Clark relative to Bristol Bay and the Kvichak drainage.

Concern for sockeye populations in the Kvichak watershed, and a lack of basic biological information, led to a cooperative research program in Lake Clark National Park and Preserve. Five primary objectives were defined with input from tribal councils, academics, federal and state managers, and local residents. The overall goal is to provide better scientific information to managers to aid in the conservation and perpetuation of sockeye salmon originating in Kvichak.

Research Objectives

Objective 1: Estimate annual abundance and monitor trends in the number of sockeye salmon returning to the

Newhalen River and Lake Clark National Park and Preserve.

Sockeye salmon migrate close to riverbanks *(Figure 6c)* where water flows are reduced due to friction; fish save energy needed for spawning by swimming near shore. This means one can estimate the number of returning sockeye salmon by counting from towers *(Figure 6a)* placed on riverbanks, 24 hours a day, 10 minutes per hour. The hourly counts are multiplied by six and summed to estimate escapement. In addition, researchers also monitor the age and size of the escapement for long-term population studies *(Figure 6b)*.

Escapements into the Kvichak have been monitored since the 1950s, while escapements to the Newhalen River and Lake Clark National Park and Preserve have been monitored sporadically since the 1980s *(Table 1)*. Researchers resumed escapement estimates into the Newhalen River in 2000. Counts from the last three years indicate Newhalen River and Lake Clark escapements are depressed but relatively stable at about 200,000 fish, compared to the Kvichak escapement, which continues to decline *(Table 1)*. This indicates sockeye salmon populations originating in Lake Iliamna are experiencing a more severe decline than Lake Clark sockeye salmon populations. Continued monitoring is essential to reveal long-term trends between the two lakes of the Kvichak watershed.

Objective 2: Examine historic salmon abundance by looking at annual layers of a marine isotope ($\delta^{15}N$) left in lake sediments from sockeye salmon carcasses.

A study of long-term changes in salmon abundance will help place the more recent trends into a larger perspective. Scientists can reconstruct long-term changes in salmon abundance, over thousands of years, from lake sediment core analysis. Every year, salmon carcasses release marine derived nutrients into their freshwater environments, forming a layer of a marine derived isotope on the lake bottom. Changes in the abundance of nitrogen isotopes as you move down the core (back in time) reflect changes in the numbers of returning fish. Lake Clark sediment cores were collected last winter *(Figure 7)* and are being analyzed to evaluate fluctuations in salmon returns relative to climate and fishing.

Objective 3: Identify and map sockeye spawning habitats in Lake Clark.

Because Lake Clark is most turbid when sockeye salmon return to spawn, historic aerial surveys were ineffective in identifying spawning habitats. The solution to identifying glacial spawning habitats proved to be radio telemetry. In 2000 and 2001, 332 sockeye salmon were captured at the outlet of Lake Clark and tagged with a small radio tag. Every ten days fish were tracked by air or boat and their movements mapped. Of the sockeye salmon tagged, 282 were successfully tracked to 35 distinct spawning habitats, of which 18 were newly identified.

Table 1: Total Kvichak River returns, commercial catch, percent harvest and escapement estimated by the Alaska Department of Fish and Game. Escapement estimates for Lake Clark are made from towers in the upper Newhalen River.

Kvichak River					*Lake Clark*	
Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**	**Column 6**	**Column 7**
Year	**Run** (millions)	**Catch** (millions)	**Harvest Rate catch/run** (percent)	**Kvichak escapement** (millions)	**Lake Clark escapement** (millions)	**Lake Clark contribution to Kvichak escapement** (in percent)
1978	7.94	3.79	48%	4.15		
1979	24.63	13.41	54%	11.22		
1980	35.16	18.16	52%	17	1.5	8.80%
1981	6.98	5.23	75%	1.75	0.23	13.10%
1982	2.94	1.8	61%	1.14	0.15	13.20%
1983	20.09	16.52	82%	3.57	0.7	19.60%
1984	22.78	12.29	54%	10.49	3.09	29.50%
1985	13.33	6.12	46%	7.21		
1986	1.95	0.77	39%	1.18		
1987	9.56	3.49	37%	6.07		
1988	6.75	2.69	40%	4.06		
1989	19.83	11.51	58%	8.32		
1990	17.43	10.46	60%	6.97		
1991	8.05	3.83	48%	4.22		
1992	10.4	5.67	55%	4.73		
1993	9.26	5.24	57%	4.02		
1994	22.18	13.84	62%	8.34		
1995	27.55	17.51	64%	10.04		
1996	3.46	2.01	58%	1.45		
1997	1.68	0.18	11%	1.5		
1998	3.37	1.07	32%	2.3		
1999	12.59	3.39	27%	9.2		
2000	2.85	1.02	36%	1.83	0.17	9.30%
2001	1.42	0.32	23%	1.1	0.22	20.00%
2002	0.7	0	0%	0.7	0.2	28.60%

Photograph courtesy of U.S. Fish and Wildlife Service

Figure 6(a). Biologists count fish from towers as they migrate near shore.

Photograph courtesy of U.S. Fish and Wildlife Service

Figure 6(b). Age and size samples collected from the subsistence harvest and seine samples allow monitoring of reproductive success.

Photo courtesy of U.S. Fish & Wildlife Service

Figure 6(c). Sockeye salmon migrating close to the river bank.

Of the radio tagged fish, more spawned in glacial (~66%) compared to clear water (~34%) habitats. This was surprising because glacial water can suffocate developing embryos and therefore is not considered important habitat. However, the recent data indicates many of the glacial spawning sites are associated with clear water tributaries *(Figure 8)*. Embryos likely survive by being bathed in clear upwelling from these tributaries or some spring source. Most spawning (>50%) took place along beaches of Lake Clark and Little Lake Clark, and most tagged fish spawned in habitats associated with privately owned lands (51-76%).

Objective 4: Determine genetic population structure of Lake Clark sockeye salmon relative to Lake Iliamna and other Bristol Bay populations.

Sockeye salmon that return to a given watershed, such as the Kvichak, are not a homogenous group of fish. Because they follow an olfactory map that leads them back to the habitats of their birth (e.g. beaches, streams, rivers), through time, populations may diverge from each other in genetic traits. Scientists can detect such divergence using molecular genetic markers called microsatellites. In order to understand the genetic population structure of Lake Clark sockeye salmon, and relate it to other Bristol Bay populations, fin tissue was collected and analyzed from 1,442 sockeye salmon representing 15 spawning populations of Lake Clark and Lake Iliamna.

Photograph courtesy of U.S. Geological Survey

Figure 7. Dr. Patricia Heiser and Andrea Krumhardt, geologists from the University of Alaska, display a Lake Clark sediment core collected and hauled through a hole in the lake ice.

The study found a significant genetic break, or divergence, occurring at the outlet of Lake Clark. Salmon sampled below the outlet grouped with Lake Iliamna samples, while Lake Clark samples grouped together. A reduced number of genes were observed in most Lake Clark populations compared to Lake Iliamna, suggesting bottlenecks, or periods of low population abundance. Possible causes of these bottlenecks include reductions in effective population size associated with recent poor returns or from few fish originally colonizing Lake Clark. Further studies are now being conducted to better understand when the bottlenecks occurred.

Compared with other Bristol Bay populations, Lake Clark fish are different genetically and therefore identifiable, which is a valuable conservation aid to managers. For example, if returns to Kvichak continue to decline, managers of the mixed stock fishery in Bristol Bay may want to limit harvesting of fish originating in Kvichak. Rapid analysis of microsatellite markers will help determine when and where Lake Clark fish move through Bristol Bay. Fishing can then be regulated to allow more Kvichak fish to return to spawning grounds. More precise identification tools for lake-originating stocks will allow for more precise conservation decisions and measures.

Genetic tools are useful in distinguishing between populations; however, important genetic differences between populations are not all revealed through genetic analysis. Adaptive traits, or the suite of traits that natural selection favors in different habitats, have not yet been linked to easily analyzed

genes. This means scientists cannot detect some important differences between populations through genetic analysis. For example, fish spawning in different natal habitats often exhibit differences in important life history traits — time of spawning, age and size at spawning, number and size of eggs, etc. — though, we do not know which genes code for these traits. Genetic research in Lake Clark also focuses on identifying important adaptive differences between populations by estimating spawn timing and measuring age and size at maturity. Analysis of this component of the study will be completed this year and will complement the microsatellite analysis.

Objective 5. Establish a community-based research program.

Tribal leaders in villages near the proposed study revealed that they wanted better education and job opportunities for people in their communities. Beginning in 2000, a Fisheries Internship Program aimed at youth ages 17-20 was initiated and geared toward training, employing, and recruiting young people to the field of fisheries science. Interns from local villages receive intensive safety and job training. They assist with all aspects of the research program including escapement counts, radio tagging and tracking, genetic sampling, age and size monitoring, data entry and report preparation. Eight students have participated in the program to date.

The National Park Service has initiated a Biotechnician Training Program, which complements the USGS internship by providing a wide diversity of fisheries science course offerings. Students continue to gain valuable hands on training from the ongoing research program. Students that excel in the Biotechnician program receive preferential treatment for summer employment in the USGS Fisheries Internship Program.

Conclusions

The cooperative sockeye salmon research program in Lake Clark has provided both the National Park Service and state fishery managers with valuable scientific information with which to conserve sockeye salmon for future generations. Research to better understand factors contributing to the current decline in the Kvichak is ongoing. Rebuilding of the Kvichak watershed sockeye salmon populations and conservation of their genetic diversity will help ensure population productivity, resiliency and perpetuation into the future.

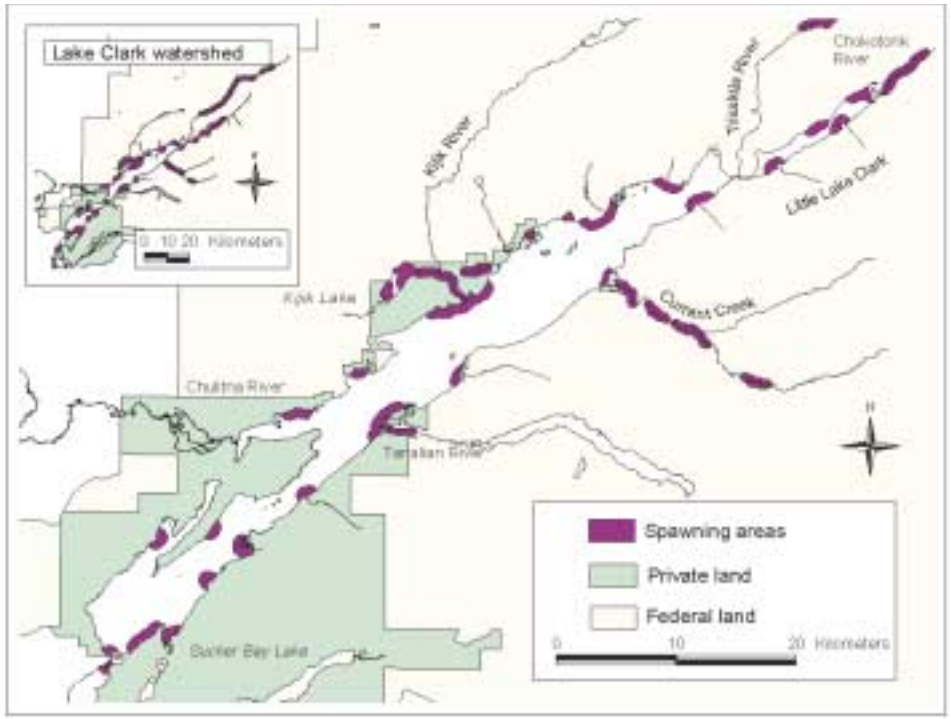

Figure 8. Sockeye salmon spawning habitats identified through radio telemetry and visual observation. Habitats are depicted relative to land ownership in Lake Clark, 2000 and 2001.

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Pioneer Arctic Archeologist J. Louis Giddings

Courtesy of Haffenreffer Museum of Anthropology (49-19)

The Nakarak family washing artifacts on the beach at Iyatayet, Norton Bay. Photograph by J.L. Giddings.

Left: J. Louis Giddings and Almond Downey at the Battle Rock site, Cape Krusenstern. Photograph by Douglas Anderson.

Courtesy of Haffenreffer Museum of Anthropology (61-DA-149)

By Becky Saleeby

J. Louis Giddings dedicated his professional life to understanding the people and the prehistory of Northwest Alaska. During almost three decades of prolific scientific fieldwork (1936-1964), he made discoveries that greatly changed prevailing views on the antiquity and complexity of Arctic cultures. As a result of his work, notably on the Kobuk River, Norton Bay, the Choris Peninsula, and Cape Krusenstern, he authored several books and a long list of journal papers about these cultures. His legacy is far greater than the sum of these scientific studies, however, and is nowhere more evident than in the vast expanse of Cape Krusenstern National Monument, designated in 1978 primarily to protect and interpret its incredible archeological resources. It was there some 20 years earlier that Giddings, with the assistance of his Iñupiaq boatman, Almond Downey, discovered a long sequence of ancient beach ridges. Preserved on the ridges was evidence of Arctic prehistory from about 6,000 years ago up through recent times.

National recognition of the scientific significance of the area first came in 1973, when the Cape Krusenstern archeological district, composed of hundreds of sites on 114 beach ridges, was designated as a National Historic Landmark. Two other sites Giddings excavated, the Iyatayet site on Norton Bay and the Onion Portage site on the Kobuk River, were also designated National Historic Landmarks. Beyond Giddings' contributions on the national scale are those on a more personal level. The bonds of cooperation and mutual respect he forged with his Iñupiat crew and friends are still remembered today by elders — Almond and Ruth Downey, Nelson Greist and Wilson Tickett. In his book, *Ancient Men of the Arctic*, he credits their knowledge of the land and its people as essential to his success throughout his years of Alaskan fieldwork.

Born in Caldwell, Texas in 1909, Giddings heeded the call to the northland early in life. He completed his undergraduate degree at the University of Alaska Fairbanks (UAF) in 1932 and ventured farther north in 1934 to spend a winter in Kotzebue, which would later be the staging point for many of his expeditions. Although his graduate education and later teaching positions took him away from Alaska, his research interests always brought him back to the far north.

One of his early scientific interests was in the field of dendrochronology — the dating of wood samples based on growth rings. The variations in the tree rings occur in a living tree as a response to local environmental conditions as the tree grows. Giddings' work with tree rings initially pertained to the study of past climates; however, archeology also benefitted from the cross-dating of logs or wood samples. When a tree is newly cut, its rings can be dated to a modern calendar. This information can then be correlated to similar patterns of rings in wood, long dead, found within prehistoric sites. Giddings learned these techniques from the father of dendrochronology, A. E. Douglass, at the University of Arizona and successfully applied them in the Arctic.

In order to have adequate comparative material for his studies, Giddings began collecting wood samples from placer gold operations around Fairbanks in 1936 and continued this research when he returned to UAF to teach in 1938. At that time, prior to the application of radiocarbon dating, it was difficult to accurately date artifacts collected from sites. Radiocarbon dating, based on the half-life of carbon from